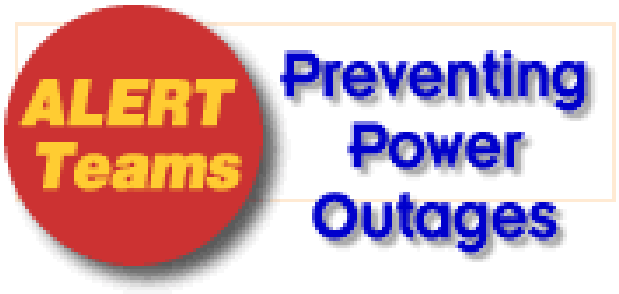
ASSESSMENT OF LOAD AND ENERGY REDUCTION TECHNIQUES (ALERT)



This is Section 2a of the ALERT Book, which provides guidance for teams conducting energy use assessments at federal sites as part of the Assessment of Load and Energy Reduction Techniques (ALERT) Program.

The ALERT Book is published in five sections:

ALERT Book, Section 1. http://www.eren.doe.gov/femp/techassist/pdf/alertbook_1.pdf
ALERT Book, Section 2a. http://www.eren.doe.gov/femp/techassist/pdf/alertbook_2a.pdf
ALERT Book, Section 2b. http://www.eren.doe.gov/femp/techassist/pdf/alertbook_2b.pdf
ALERT Book, Section 2c. http://www.eren.doe.gov/femp/techassist/pdf/alertbook_2c.pdf
ALERT Book, Section 3. http://www.eren.doe.gov/femp/techassist/pdf/alertbook_3.pdf

Options for Evaluating Economizer Performance

2002 NASA Environmental Management & Energy Conference

March 12-14, 2002, Norfolk, Virginia

John Hail, (509) 372-4799, john.hail@pnl.gov
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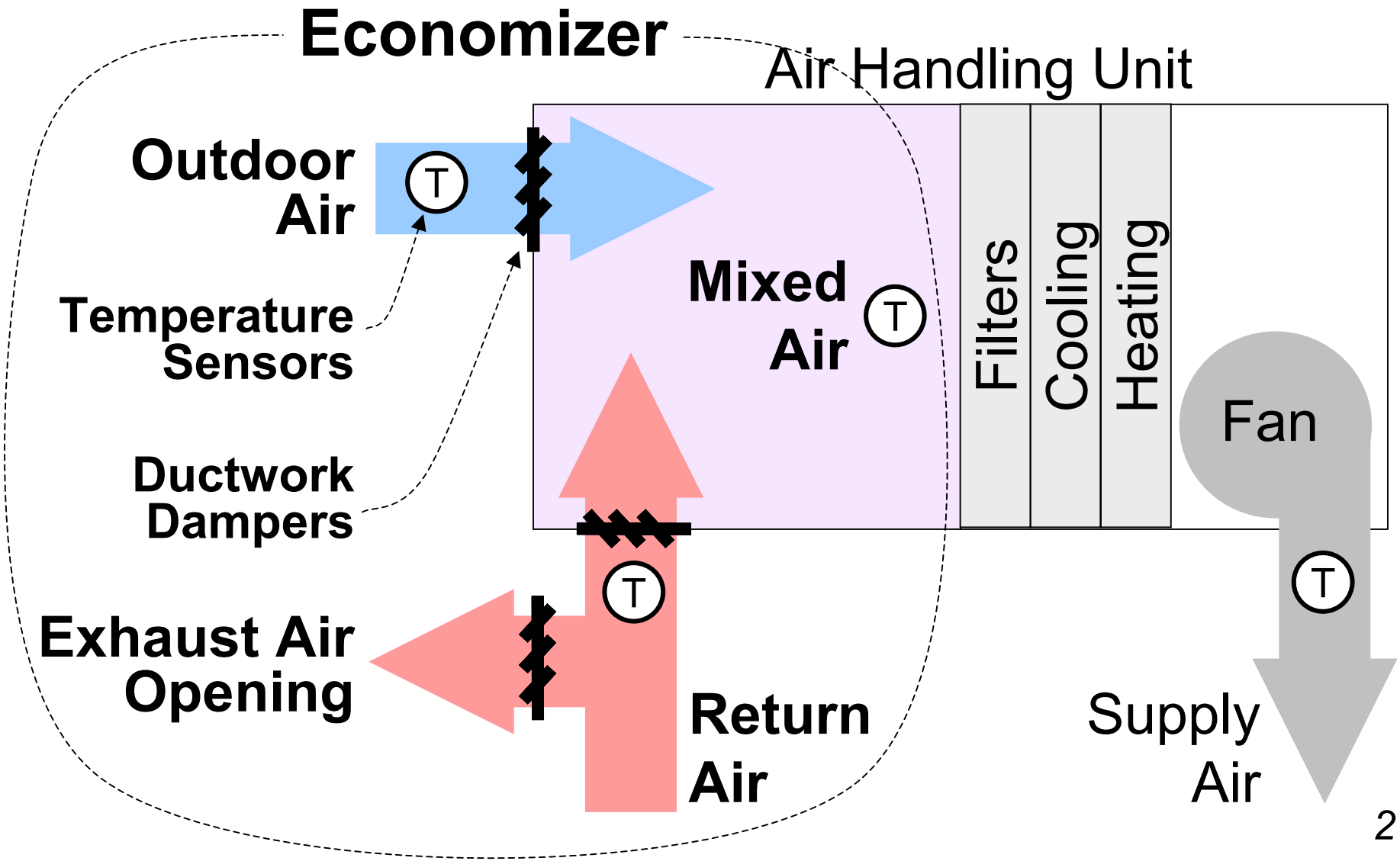
DOE Pacific Northwest National Laboratory

Economizer Components Diagram



Economizer Protocol Options

- ALERT HVAC checklist: temperature spot checks and simple calculation
- Data loggers and spreadsheet analysis
  - Site's existing controls system or HOBOs
  - PG&E's Excel template
- Integrated, portable logger & analysis
  - Rooftop A.C. Packaged Unit Diagnostician
- Permanent, automatic, and complex-wide monitoring and diagnostics
  - Whole Building Diagnostician

Comparison of Protocol Options

			Whole Building Diagnostician		
			Rooftop Unit	Economizer Module	
	ALERT	PG&E		Standard Install	Batch Mode
Tools	Hand-held temp. probe & calculator	Data loggers (HOBOs or DDC) & PG&E's Excel template	Standalone black box + LAN-Phone	Compatible bldg control system & OAE software	< Similar (site gets data & gives to PNNL for processing)
Test Period	15-30 minutes	2 weeks +	2 weeks +	Building lifecycle	2 weeks + Could be pilot or demo
Data	3 temp. spot checks	Hourly or better data, multiple points	Real-time data for all points	Hourly or better data from min. of 7 points	< same
Initial Report Form	Field notes	Excel & data	Real time diagnostic & reporting	Diagnostic charts, notes, & data	< same
Value	Energy estimate	Ventilation performance. Energy impact to be developed	Ventilation performance. Energy impact to be developed	Hourly performance of ventilation & energy	< same but limited test period
Tools $	Not app.	HOBOs; free spreadsheet	$2K each Unit	SW free	Not app.
Labor $	In ALERT package	TBD	1-4 hrs + travel	1-2 weeks, $15-20K (install, train, & help retune)	1-5 days

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ALERT Protocol

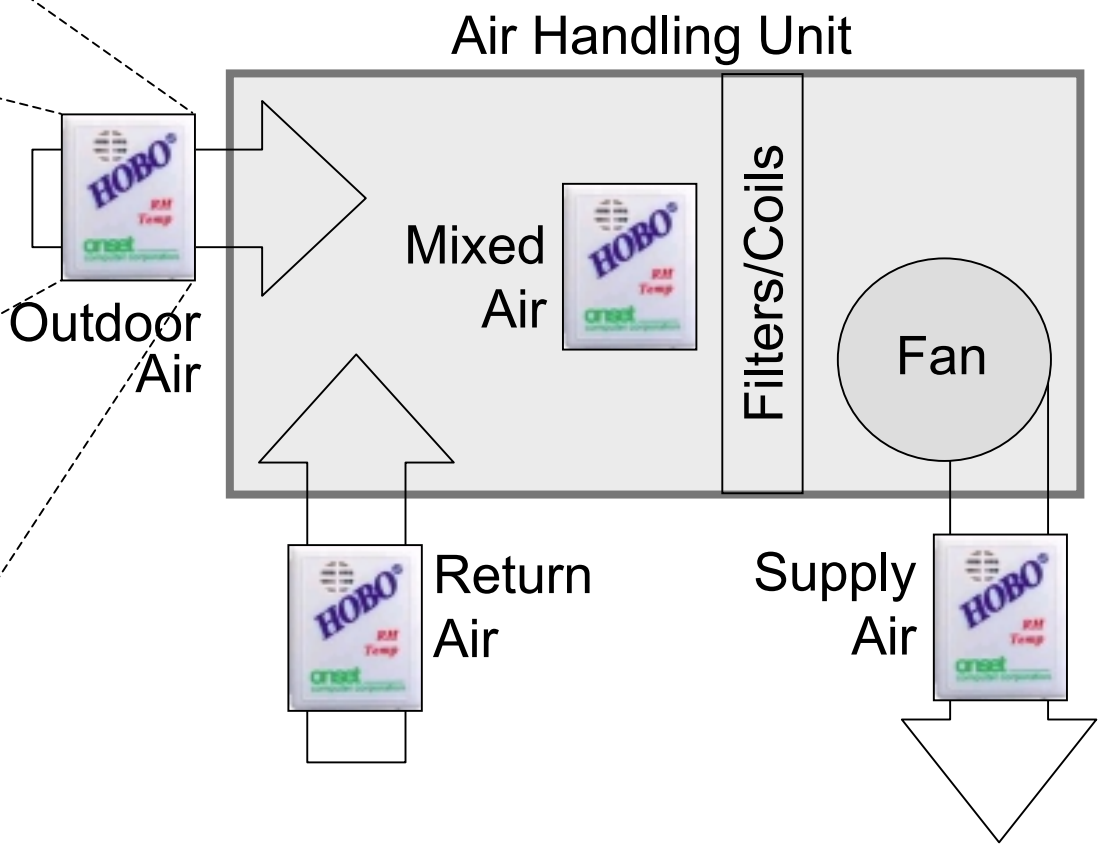
- **Use ALERT HVAC Checklist (page 5):**
  - **Override controls to check dampers at various ODA settings**
  - **Take temperature measurements at AHU and calculate mixed air fraction:**

$$\text{Mixed Air Fraction} = \frac{\text{Mixed Air} - \text{Return Air}}{\text{Outdoor Air} - \text{Return Air}}$$

PG&E Protocol – Get Data

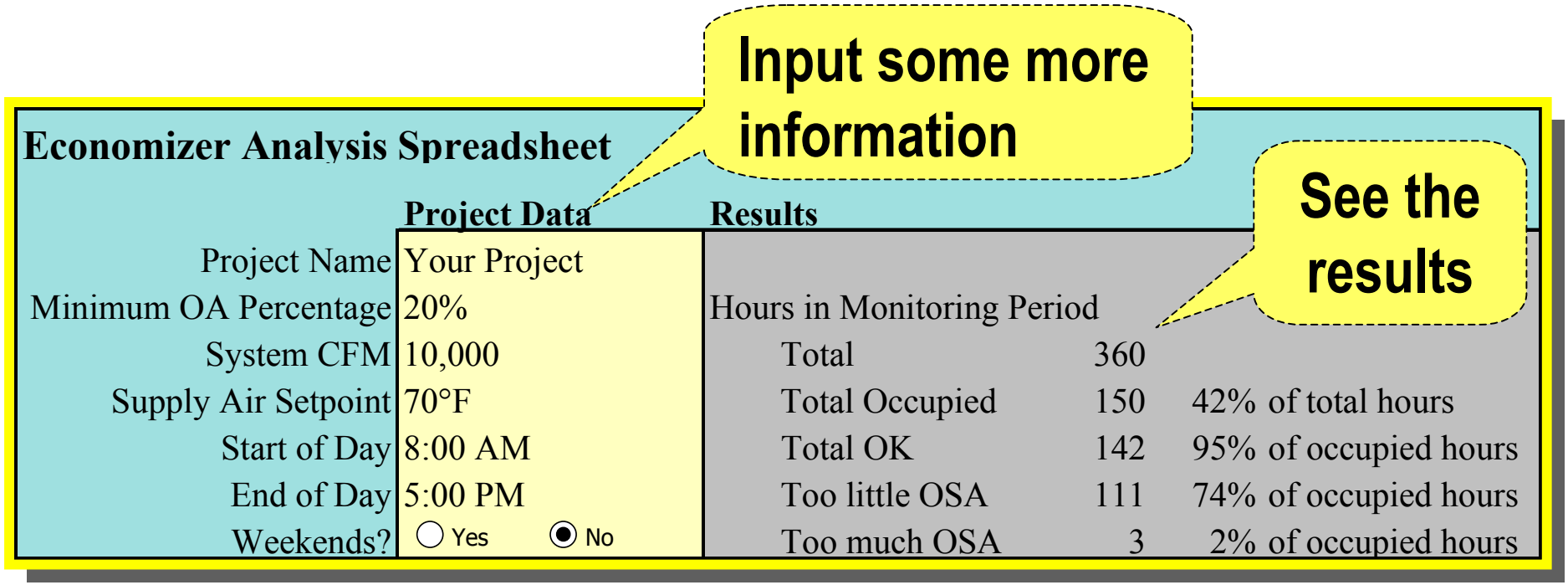
- **Place 4 temperature sensors/loggers:**

Temperature data logger (2” x 2.5”)



PG&E Protocol – Use Data

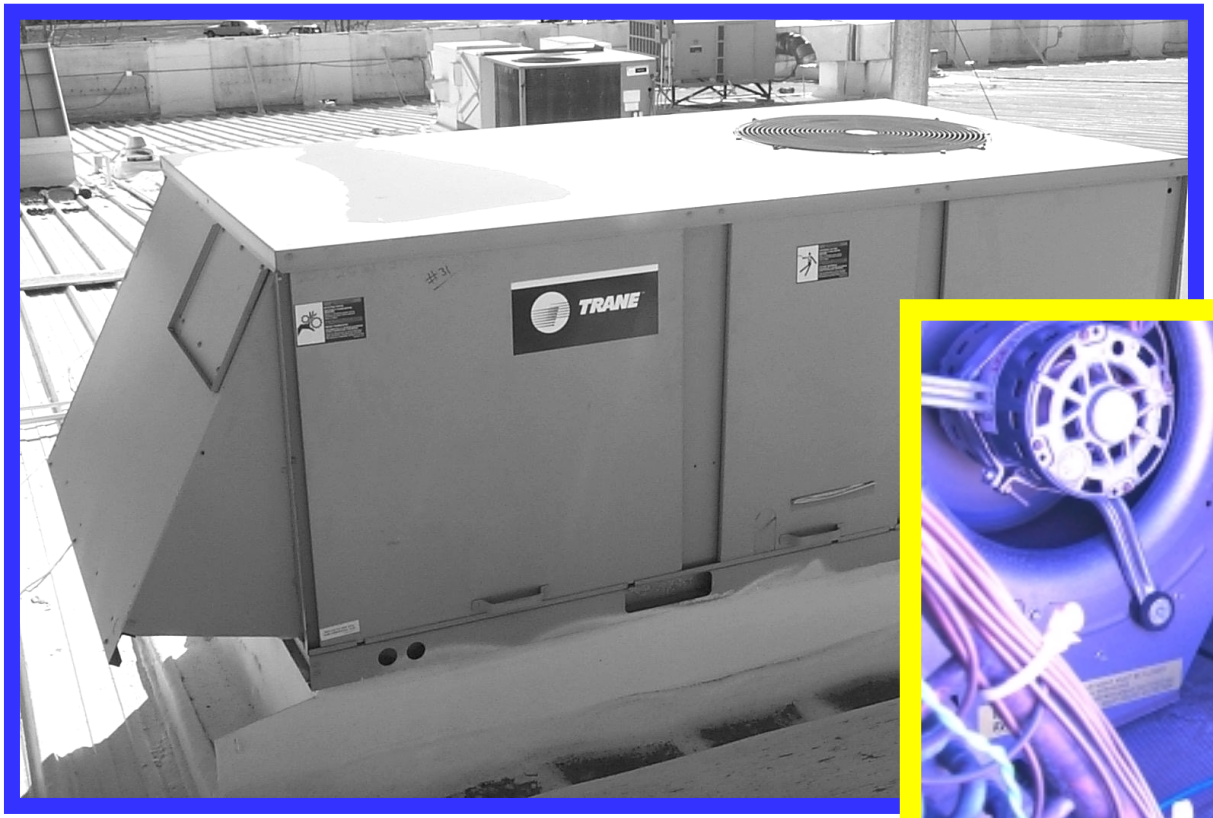
- Import data into PG&E's Excel template



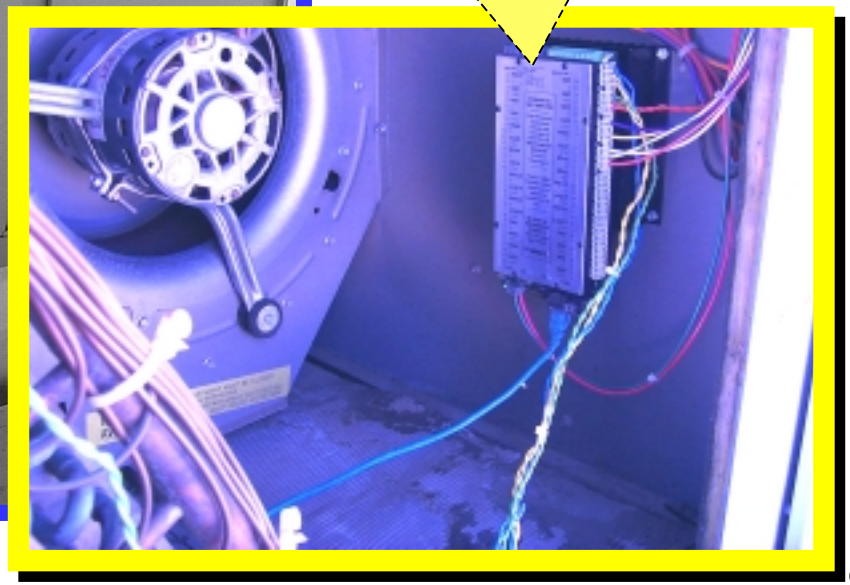
- Soon: template to estimate cost-impacts

Diagnostician for Rooftop AC Units

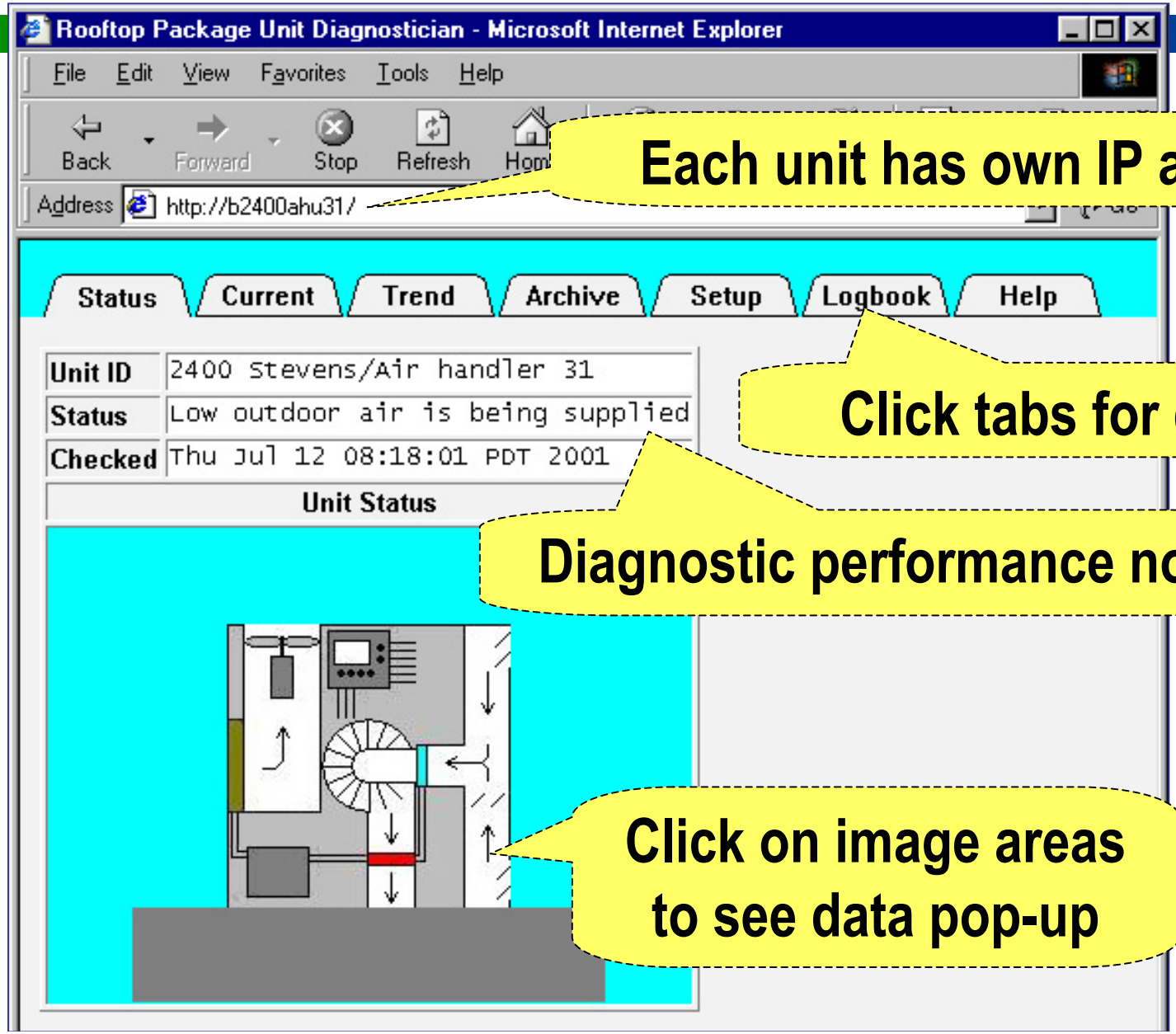
- **Integrated sensors, data logger, evaluation, & web-delivered reports**



Diagnostician installed in unit



Diagnostician Report Via Web



Each unit has own IP address

Click tabs for data

Diagnostic performance note

Click on image areas to see data pop-up

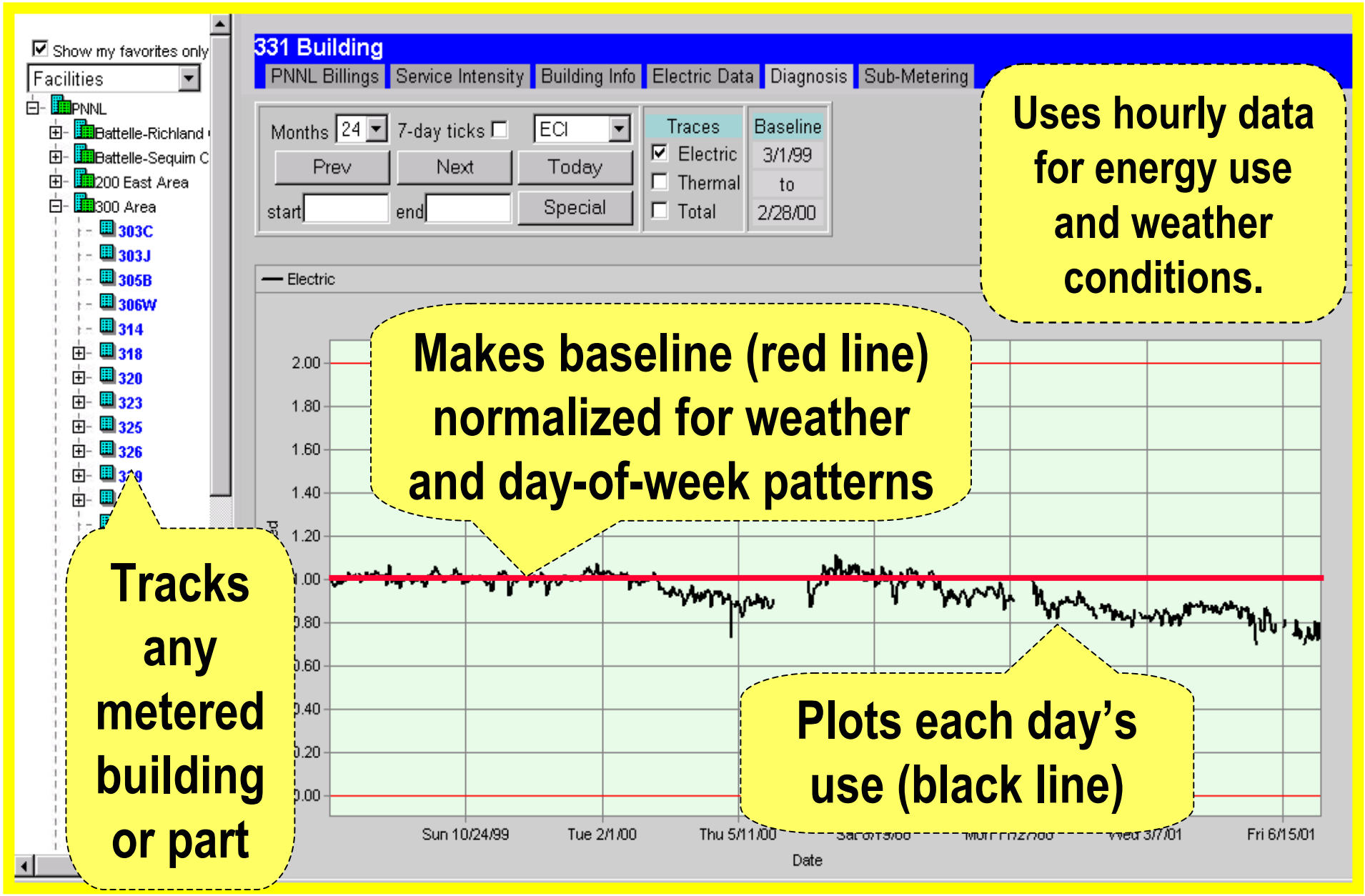
Access Diagnostician at PNNL Bldg

1. ***Start modem & log onto PNNL's internal network (not open to the public)***
2. ***Click this link:*** http://b2400ahu31/

Whole Building Diagnostician (WBD)

- **WBD design intent**
  - **Monitor & diagnose energy performance of buildings and components**
  - **Use standard metering & controls data**
  - **Automate data collection & analysis**
- **Existing WBD modules:**
  - **"Whole Building Energy" monitors daily performance of metered objects (buildings, zones, chillers, processes, et cetera)**
  - **"Outdoor Air Economizer" monitors & diagnoses hourly performance of economizers**

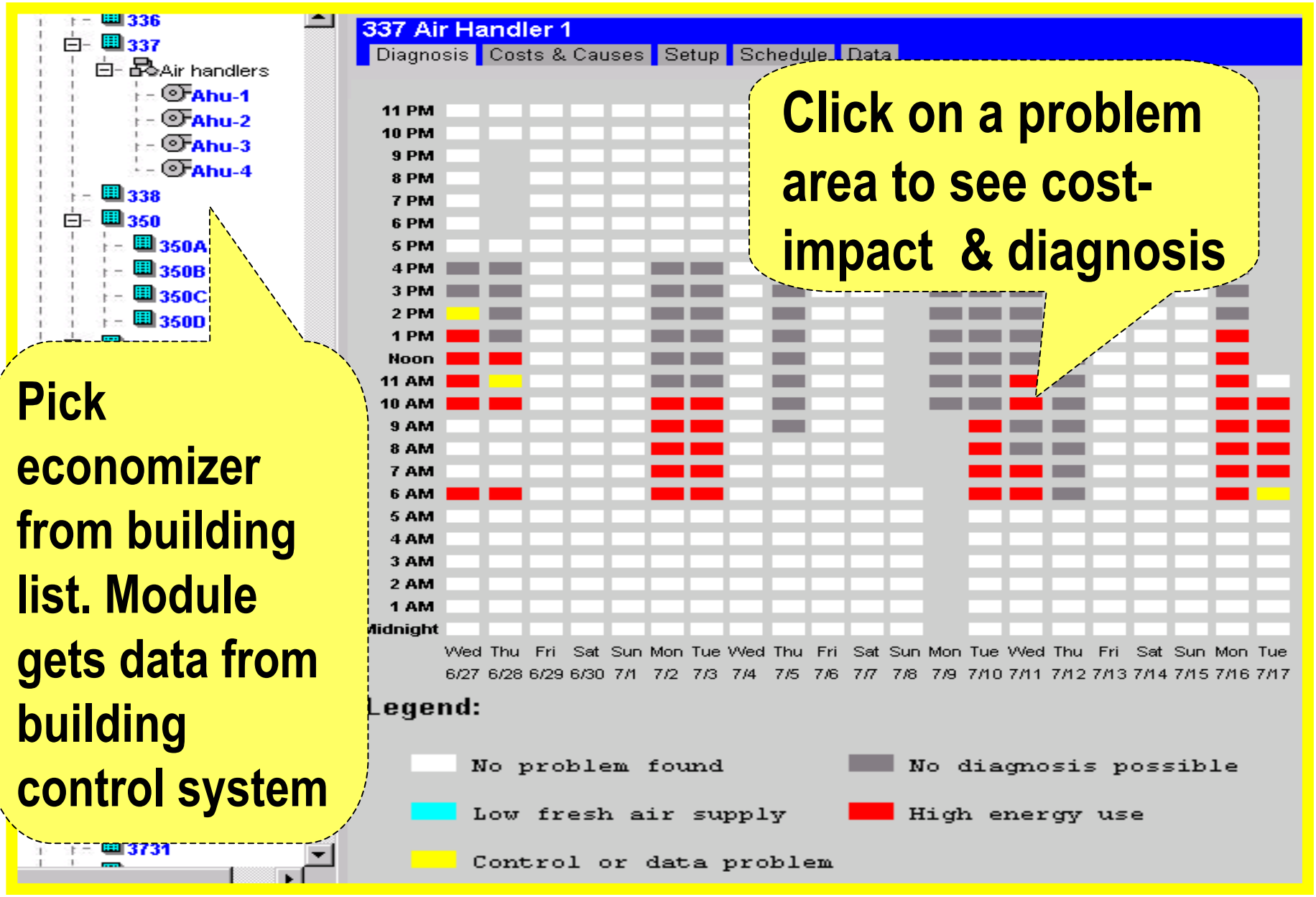
“Whole Building Energy” Screen



Data for Whole Building Module

- For any building, system, or component:
  - Time stamp (1 hour or smaller intervals)
  - Energy consumption to track (one or more needed): kWh, therms, etc
  - Outdoor temperature
  - Outdoor humidity

WBD Economizer - Main Screen



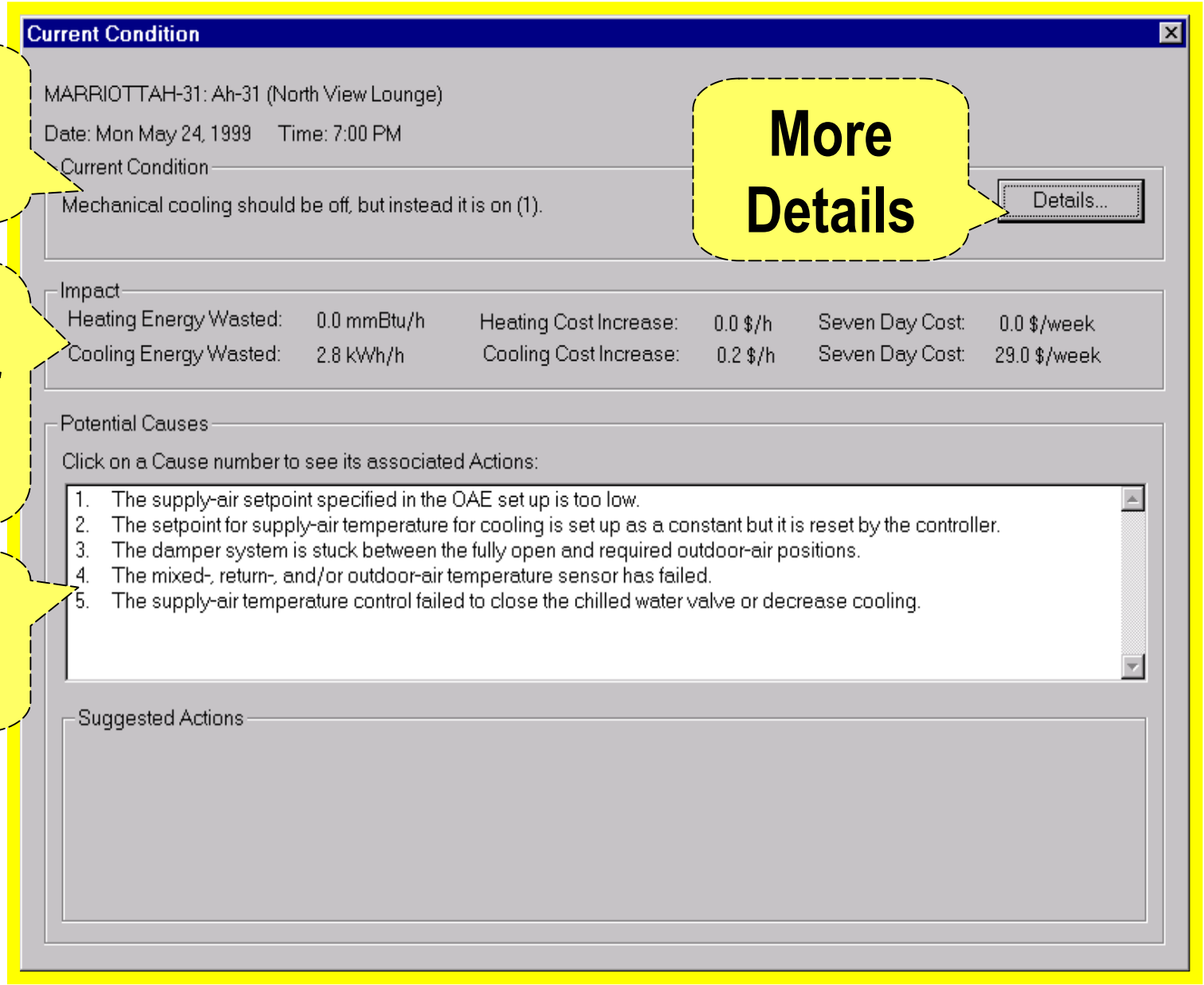
WBD Economizer - Details Screen

Current Condition

Cost-Impact of Problem

Potential Causes

More Details



Data for WBD Economizer Module

- 7 data measurements required:
  - Date & time (5-minute intervals preferred)
  - Air temperatures
    - ✓ Outdoor Air
    - ✓ Return Air
    - ✓ Mixed Air
  - On/Off status of fan
  - Heating status of AHU
  - Cooling status of AHU
- Some optional and preferred data

Go Online to PNNL WBD Installation

- **Background**
  - **WBD covers much of PNNL's 2 million S.F.**
  - **Whole Bldg module takes data from meters**
  - **Economizer module takes data from controls**
  - **Facilities Dept. made web-based reports**
- ***Go online***
  - ***Start modem & log onto PNNL's internal network (not open to the public)***
  - ***Click this link:*** http://bp/

Applying WBD Economizer Module

- Two application methods:
  - Permanent installation of WBD
  - Batch mode - manual input of historical data

WBD Economizer – Permanent Mode

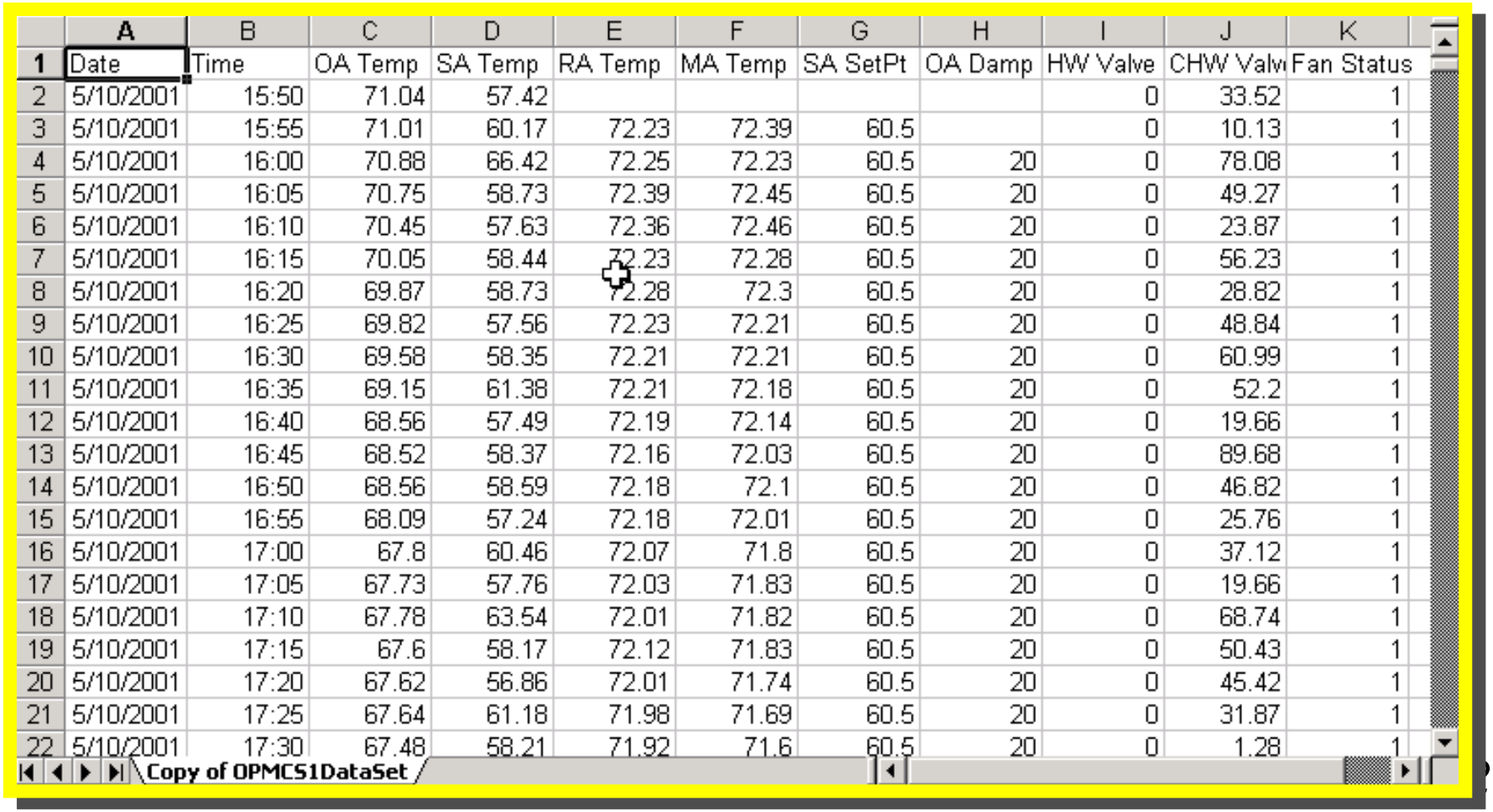
- **Permanent Installation**
  - **For sites with building controls that can provide required data**
  - **PNNL installs WBD on a dedicated PC on site to collect & process data, and to display reports**
- **Cost scale: $15-25K**
  - **PNNL labor to install WBD at site**
  - **PNNL HVAC experts to help site recommission economizers**

WBD Economizer - Batch Mode

- Batch/Manual import of data into WBD
  - Site collects required data
    - ✓ Use sites' building controls system
    - ✓ Use portable data loggers
  - Site or PNNL puts data into clean format
  - PNNL inputs & processes data at PNNL
  - PNNL emails screen shots of WBD charts and recommended corrective actions
- Cost scale: $2-5K a site (multiple economizers)

WBD Economizer - Data File Format

- **All data elements integrated into one spreadsheet or comma-delimited file:**



	A	B	C	D	E	F	G	H	I	J	K
1	Date	Time	OA Temp	SA Temp	RA Temp	MA Temp	SA SetPt	OA Damp	HW Valve	CHW Valv	Fan Status
2	5/10/2001	15:50	71.04	57.42					0	33.52	1
3	5/10/2001	15:55	71.01	60.17	72.23	72.39	60.5		0	10.13	1
4	5/10/2001	16:00	70.88	66.42	72.25	72.23	60.5	20	0	78.08	1
5	5/10/2001	16:05	70.75	58.73	72.39	72.45	60.5	20	0	49.27	1
6	5/10/2001	16:10	70.45	57.63	72.36	72.46	60.5	20	0	23.87	1
7	5/10/2001	16:15	70.05	58.44	72.23	72.28	60.5	20	0	56.23	1
8	5/10/2001	16:20	69.87	58.73	72.28	72.3	60.5	20	0	28.82	1
9	5/10/2001	16:25	69.82	57.56	72.23	72.21	60.5	20	0	48.84	1
10	5/10/2001	16:30	69.58	58.35	72.21	72.21	60.5	20	0	60.99	1
11	5/10/2001	16:35	69.15	61.38	72.21	72.18	60.5	20	0	52.2	1
12	5/10/2001	16:40	68.56	57.49	72.19	72.14	60.5	20	0	19.66	1
13	5/10/2001	16:45	68.52	58.37	72.16	72.03	60.5	20	0	89.68	1
14	5/10/2001	16:50	68.56	58.59	72.18	72.1	60.5	20	0	46.82	1
15	5/10/2001	16:55	68.09	57.24	72.18	72.01	60.5	20	0	25.76	1
16	5/10/2001	17:00	67.8	60.46	72.07	71.8	60.5	20	0	37.12	1
17	5/10/2001	17:05	67.73	57.76	72.03	71.83	60.5	20	0	19.66	1
18	5/10/2001	17:10	67.78	63.54	72.01	71.82	60.5	20	0	68.74	1
19	5/10/2001	17:15	67.6	58.17	72.12	71.83	60.5	20	0	50.43	1
20	5/10/2001	17:20	67.62	56.86	72.01	71.74	60.5	20	0	45.42	1
21	5/10/2001	17:25	67.64	61.18	71.98	71.69	60.5	20	0	31.87	1
22	5/10/2001	17:30	67.48	58.21	71.92	71.6	60.5	20	0	1.28	1

Copy of OPMCS1DataSet

Additional Information at Yahoo

- Page 5 of Checklist for HVAC, Chillers, Economizers, Boilers (a Word file)
- PG&E's flyer and Excel template
- Data Requirements for the WBD
- Summary of Economizer Protocol Options

Questions & Discussion

- Which protocols for now? Which for future? Considerations:
  - Limits of ALERT budget for each site assessment
  - Capabilities of
    - ✓ Site infrastructure and staff
    - ✓ ALERT team members
- What else?

331 Building

PNNL Billings | Service Intensity | Building Info | Electric Data | Diagnosis | Sub-Metering

Months All 7-day ticks ☐ Quantity

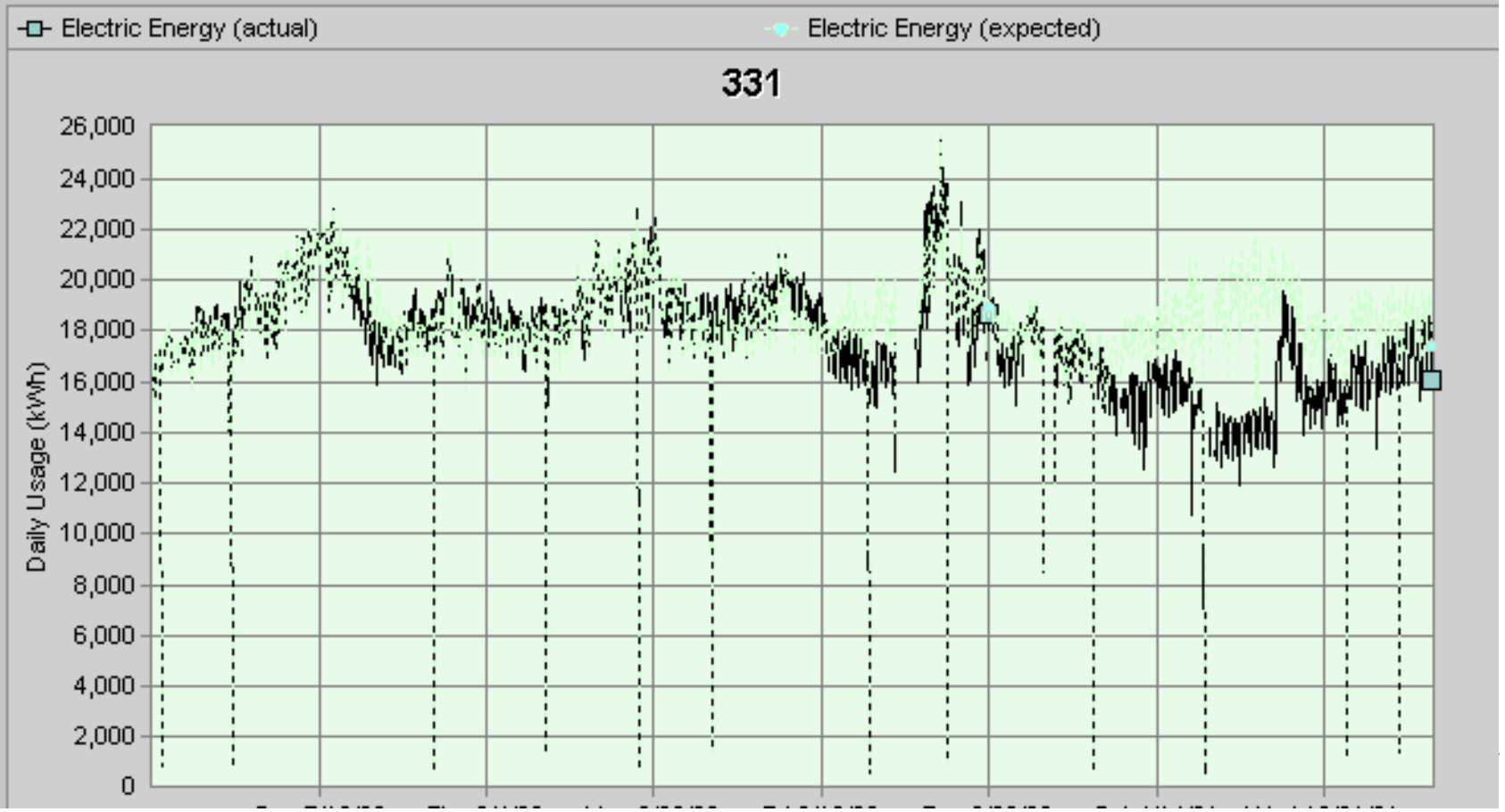
Prev | Next | Today

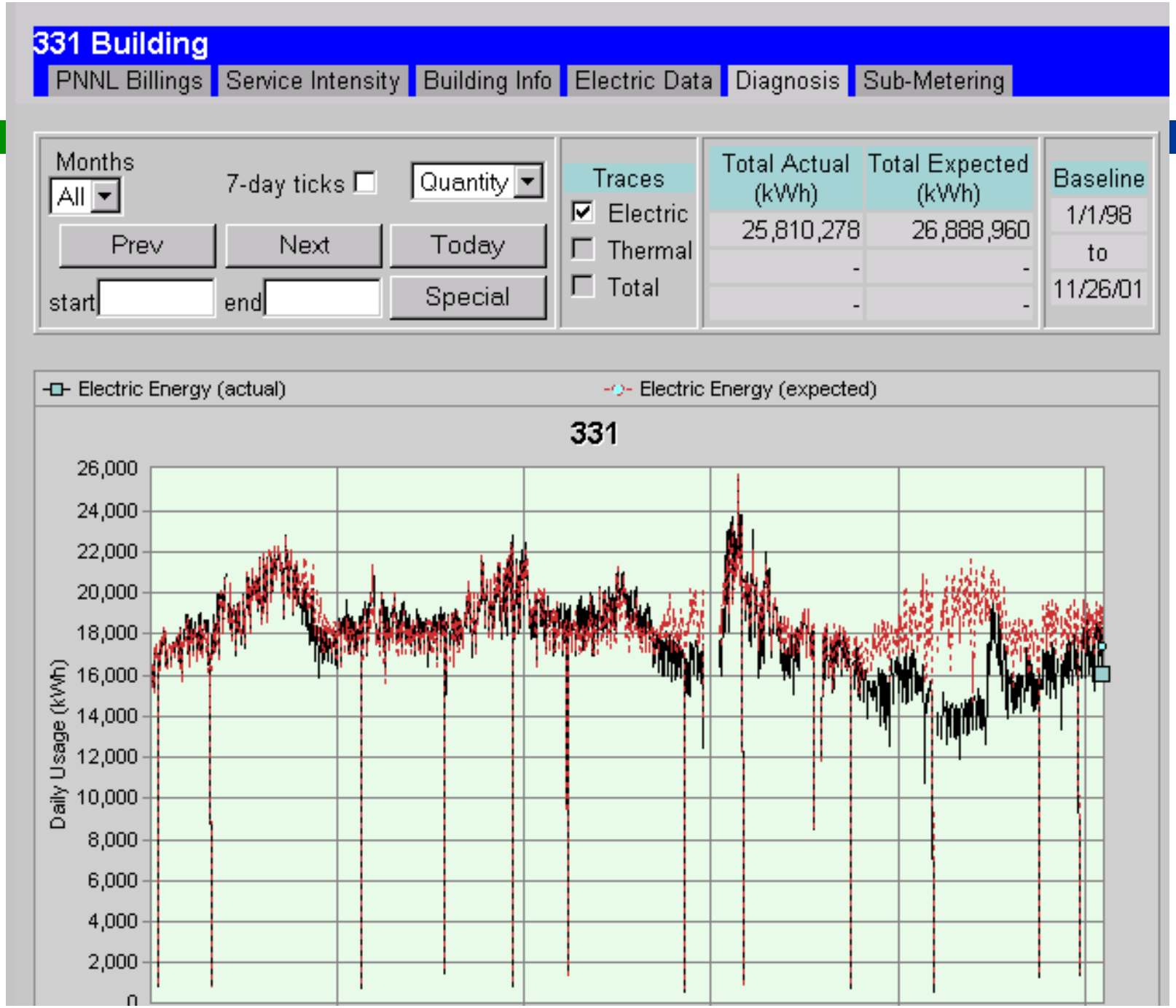
start end Special

Traces
- ☑ Electric
- ☐ Thermal
- ☐ Total

Total Actual (kWh)	Total Expected (kWh)
25,810,278	26,888,960
-	-
-	-

Baseline
1/1/98
to
11/26/01




331 Building
PNNL Billings
Service Intensity
Building Info
Electric Data
Diagnosis
Sub-Metering
Months
All
7-day ticks
Quantity
Prev
Next
Today
start
end
Special
Traces
Electric
Thermal
Total
Total Actual (kWh)
Total Expected (kWh)
25,810,278
26,888,960
Baseline
1/1/98
to
11/26/01
Electric Energy (actual)
Electric Energy (expected)
331
Daily Usage (kWh)
26,000
24,000
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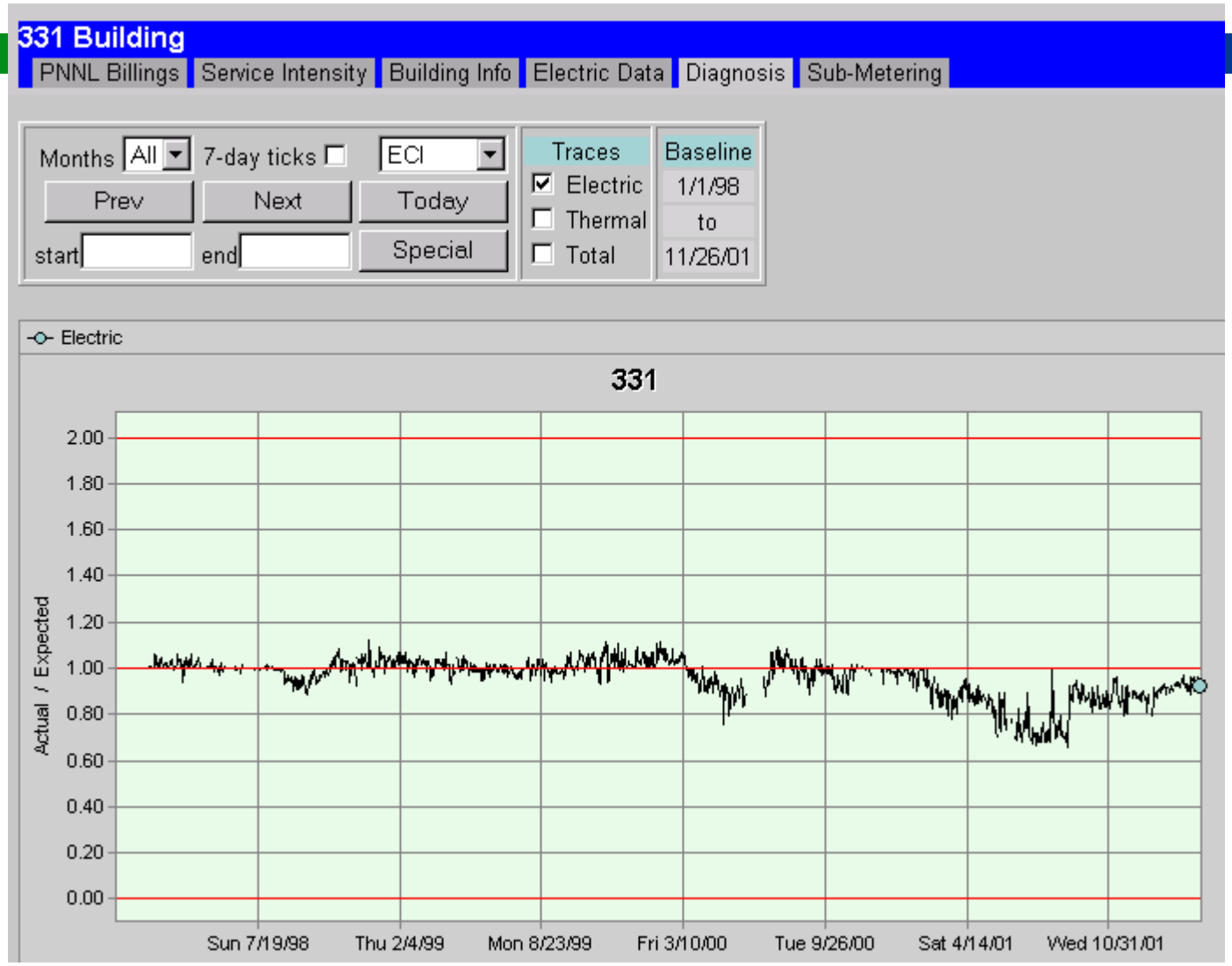
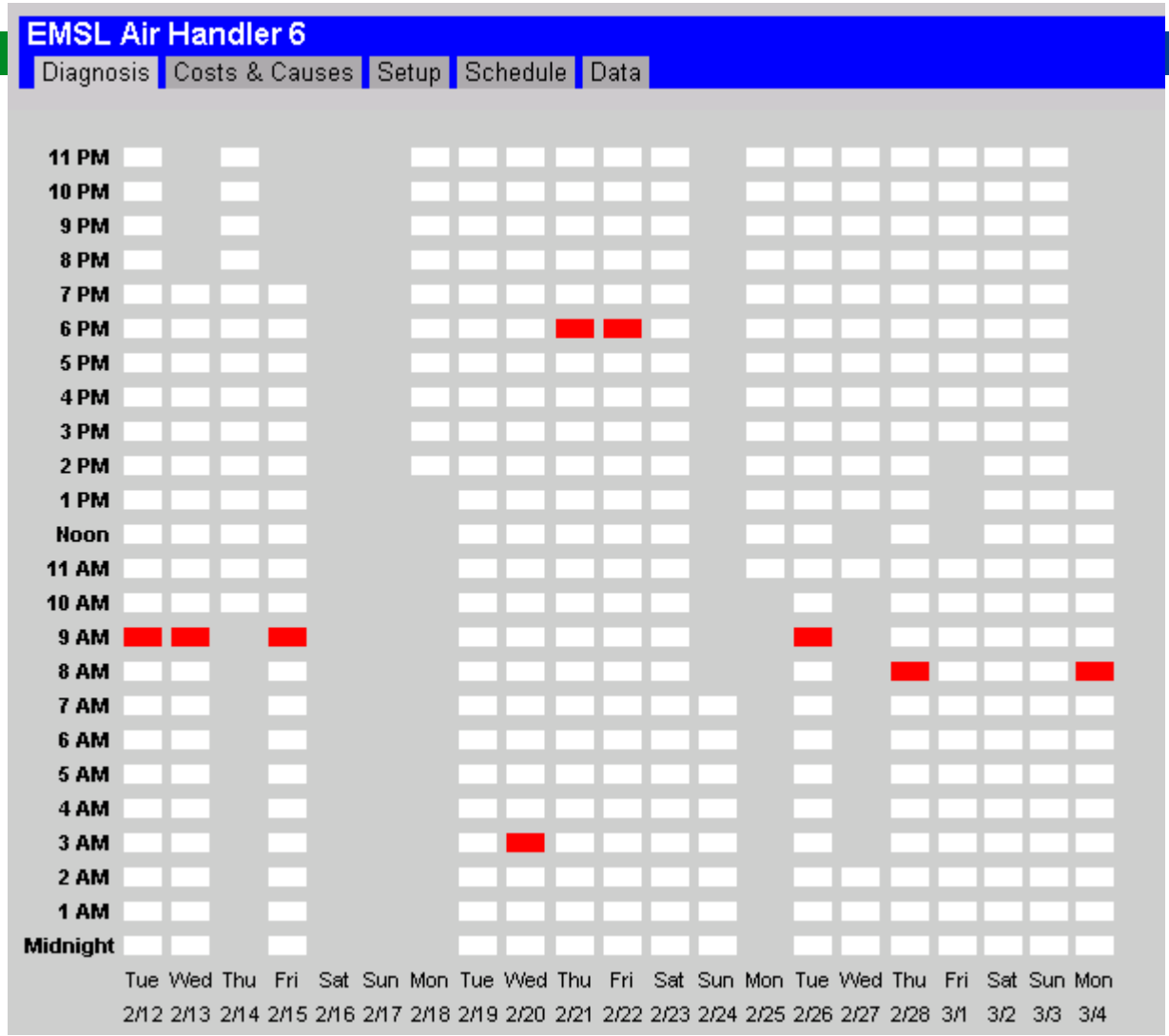
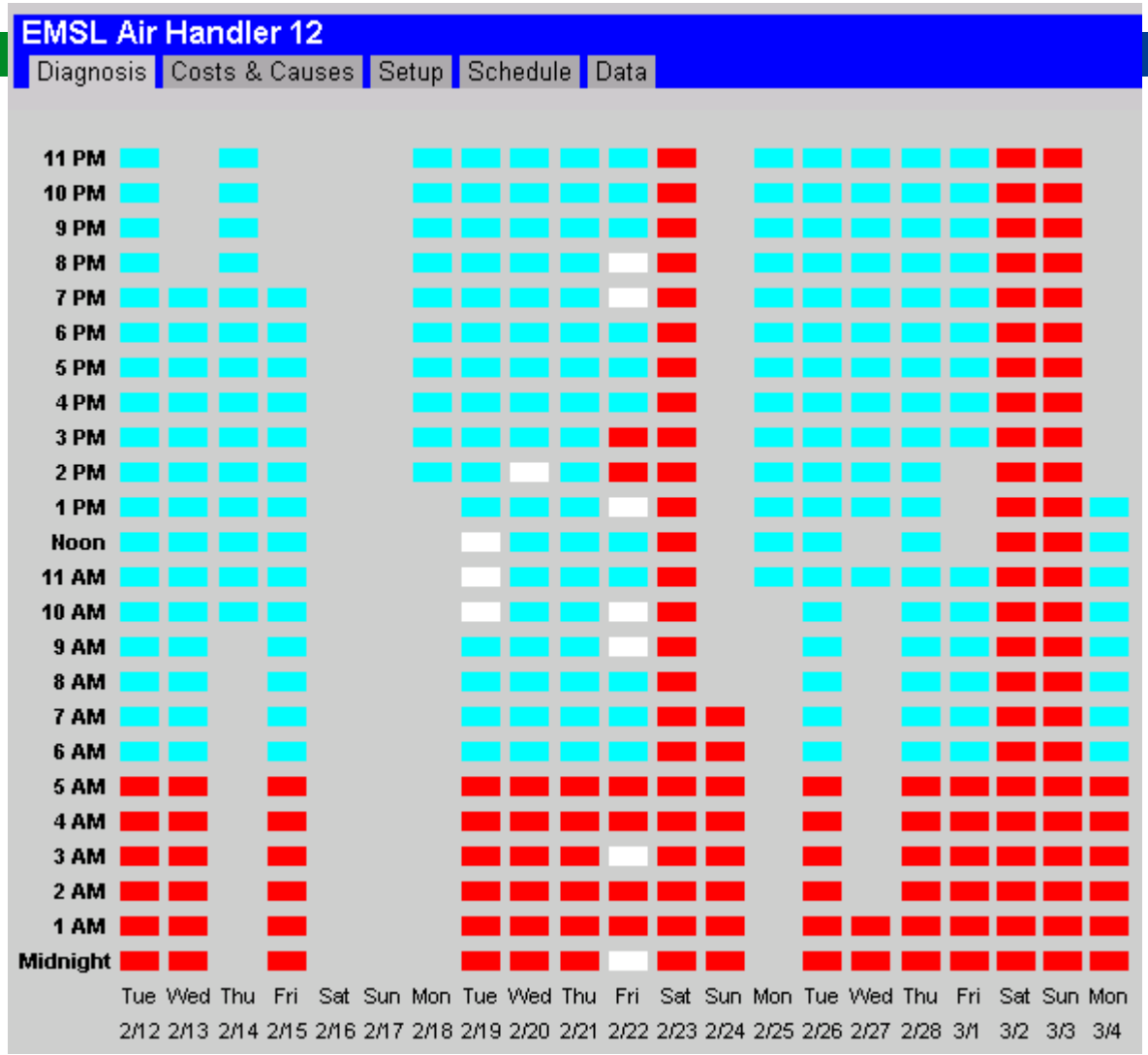
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0


331 Building
PNNL Billings
Service Intensity
Building Info
Electric Data
Diagnosis
Sub-Metering
Months All
7-day ticks
ECI
Prev
Next
Today
start
end
Special
Traces
Electric
Thermal
Total
Baseline
1/1/98
to
11/26/01
Electric
331
Actual / Expected
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Sun 7/19/98
Thu 2/4/99
Mon 8/23/99
Fri 3/10/00
Tue 9/26/00
Sat 4/14/01
Wed 10/31/01


EMSL Air Handler 6
Diagnosis
Costs & Causes
Setup
Schedule
Data
11 PM
10 PM
9 PM
8 PM
7 PM
6 PM
5 PM
4 PM
3 PM
2 PM
1 PM
Noon
11 AM
10 AM
9 AM
8 AM
7 AM
6 AM
5 AM
4 AM
3 AM
2 AM
1 AM
Midnight
Tue Wed Thu Fri Sat Sun Mon Tue Wed Thu Fri Sat Sun Mon Tue Wed Thu Fri Sat Sun Mon
2/12 2/13 2/14 2/15 2/16 2/17 2/18 2/19 2/20 2/21 2/22 2/23 2/24 2/25 2/26 2/27 2/28 3/1 3/2 3/3 3/4


EMSL Air Handler 12
Diagnosis
Costs & Causes
Setup
Schedule
Data
11 PM
10 PM
9 PM
8 PM
7 PM
6 PM
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4 PM
3 PM
2 PM
1 PM
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Wed 2/20
Thu 2/21
Fri 2/22
Sat 2/23
Sun 2/24
Mon 2/25
Tue 2/26
Wed 2/27
Thu 2/28
Fri 3/1
Sat 3/2
Sun 3/3
Mon 3/4